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INVESTIGATION OF USE OF SPACE DATA IN WATERSHED HYDROLOGY

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16. Abstract <p>Ground truth data have been compiled and 256 rainfall runoff events have been used to determine coefficients for two storm runoff equations that apply to the 20 study watersheds.</p> <p>Two scenes have been processed using CCT data. Data pertinent to each of the study watersheds have been excerpted from the tapes. A computer program and display technique has been developed to retrieve the data from irregular shaped areas and store it in a format that allows future display of only the area desired.</p> <p>Means, standard deviations, and distributions have been determined for extreme dry and extreme wet conditions in the dormant season. Mean digital values show some variation between watersheds when dry, but no significant differences when wet. Standard deviations of digital values diminish drastically under wet dormant conditions. Thus the standard deviations may be a good indicator of influence of moisture. Distributions of seven bit values show that odd numbers are prevalent and irregular distribution may influence some classification schemes now in use.</p>			
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INTRODUCTION

The objectives of this study are:

1. To attempt to discover if MSS data can be used to characterize the coefficients of runoff equations for watersheds.
2. To compare the performance of hydrologic models using manually determined parameters versus ERTS derived parameters.
3. To modify an existing hydrologic model to utilize ERTS data and compare the modified model's performance with a standard model.

Ground truth to be used is based on recorded hydrologic data from the past 11 years. The watersheds used as a base for this study are located in a portion of the Southern Great Plains area that has a mean annual rainfall of 31 inches. The initial effort of the study has been directed toward compilation of past records and fitting the data to two runoff equations.

Two scenes of ERTS data have been received on computer tapes and preliminary investigations have been made to gain some experience with the digital data.

HYDROLOGIC DATA AND PROCESSING

Eleven years of hydrologic records for 20 watersheds was searched for all rainfall events producing significant runoff. Two hundred and fifty-six storm runoff events were selected for the entire 20 watersheds. Events per watershed ranged from 9 to 21 with small watersheds in the eastern portion of the study area having the largest number of usable events.

Data compiled for each storm event used included weighted mean rainfall, runoff, antecedent rainfall index (30-day, decayed), antecedent rainfall index (5-day sum), and maximum hourly intensity. Runoff was adjusted to an estimate of the contributing area using records of farm pond storage.

The rainfall and runoff values were used in the SCS runoff equation (Appendix) to calculate actual curve numbers for each storm event. A large majority of the events were in the Class I category of antecedent precipitation index used by SCS. It is apparent from a study of these events that conversion from one class to another in the SCS routine is not appropriate to storms in this study area. Therefore only Class I storms were used to derive mean curve numbers for watersheds in this study. A list of final mean calculated curve numbers for each watershed can be found in the Appendix of this report.

Attempts were made to fit another runoff equation to the data using precipitation, 30-day antecedent precipitation, and maximum hourly intensity as variables. Very poor results were obtained after trying several linear combinations of the variables. Ultimately the intensity was deleted and runoff was fitted to rainfall alone, then deviations in predicted runoff from measured runoff were fitted to the 30-day decayed antecedent precipitation thus leading to the exponential values appropriate for precipitation and antecedent precipitation. These exponents were derived using all 256 storm runoff events.

The exponents were then fixed in Equation 2 (Appendix) and a mean coefficient fitted for each watershed. The coefficients (Appendix) and

exponents accepted for this simple equation predict runoff that has a multiple correlation with the measured runoff of .7220, whereas the SCS equation using curve numbers accepted for this study produce a multiple correlation of .7112 when compared to the measured runoff. This indicates the two equations used are of comparable quality for predicting storm runoff in this region. Use of only one or two storm parameters cannot be expected to produce better results than this.

ERTS DATA PROCESSING

The original magnetic tapes of digital data for both scenes ordered were first duplicated to produce working copies. The study area at Chickasha was located across the overlap of the frames, therefore a procedure was developed to patch a portion of the north tape to the south one. Using this technique the entire study area was represented on two files containing adjoining portions of the study area. The entire study area could then be displayed on the 1800 Dicomed complex at Weslaco.

Watershed maps were processed on a chart reader and a series of coordinates defining the boundaries were punched on cards. These coordinates were rotated to align with the ERTS track then expanded on the cross track axis to conform to the display. A film positive of the distorted map is used to locate coordinates on the display indicating line and word locations of the watershed boundary points.

A computer program (OKLA) written at Weslaco by M. Geautreau was used to select data for the irregular shaped watersheds. The program stores data for a rectangle encompassing the watershed desired, however

for each point outside the watershed boundary, each data point is defined as zero. Storing the watershed data in this manner allows future display of the reduced data.

Means, standard deviations, and distributions were calculated for each band over each watershed area. The first scene from September 19, 1972 has some variation in means between watershed areas, however the variation in means is drastically reduced in the second scene taken October 25, 1972. The first scene represents extremely dry conditions and the second scene represents extremely wet conditions. No change other than soil moisture occurred in this period since plant growth had stopped due to the drought and when moisture became available, temperatures were too low to stimulate sprouting of winter wheat. These scenes will be studied further to attempt to define the maximum spectral change in dormant conditions due to extremes of soil moisture. At present it appears that standard deviations of digital data over watersheds diminish with high moisture content. This may offer some means of defining antecedent moisture conditions for dormant periods.

When plotting the distribution of values in the first three bands, the excessive number of odd integers becomes apparent. It appears that the digital values in these bands can be reduced to six bit values to produce plots that will more readily indicate shifts in the distributions from scene to scene. Uneven distribution of odd and even digits may present some uncertainty if an investigator is using the distribution in a decision process for classification of crops, etc.

PROGRAM FOR NEXT PERIOD

The digital data from two fall scenes and one midwinter scene, January 23, 1973, will be studied to determine the feasibility of discriminating between watersheds having extreme differences in runoff capability. A common program for discriminant analysis should be able to detect the separability of two watersheds by using combinations of two, three, or four values at each picture element. The January 23, 1973 scene has not been received and the processing techniques for separating and storing the pertinent data for each watershed must be executed prior to the discriminant analysis.

Some data from the Bendix 27 channel scanner was obtained one day after the January scene and will be examined using the same discriminant analysis techniques. At this time there is no plan to calculate the means and distribution of the aircraft data since no additional flights with this equipment are planned.

Additional information for ground truth will be obtained from the Soil Conservation Service to complete a list of curve numbers that field engineers have developed by hand processing over the test watersheds.

CONCLUSIONS

The difference in mean spectral response between watersheds with widely varying runoff characteristics is extremely small for dormant scenes. Variation in the means is even less when wet conditions prevail. Some estimate of the influence of moisture conditions may be possible using two scenes with little or no change in other variables. Standard deviations are reduced over dormant areas with the occurrence of wet conditions.

Attempts to extract data from the ERTS computer tapes over irregular shaped areas have been highly successful. Data pertinent to irregular shaped areas can be rapidly extracted and stored in a manner such that display of the selected area is possible.

RECOMMENDATIONS

None.

APPENDIX

Equation 1 - Soil Conservation Service (SCS rainfall-runoff equation)

$$Q = \frac{(P - 2.S)^2}{P + .8S}, \text{ where } S = \left[\frac{1,000}{CN} - 10 \right]$$

The equation can be expressed as

$$Q = \frac{\left[P - .2 \left[\frac{1,000}{CN} - 10 \right] \right]^2}{P + .8 \left[\frac{1,000}{CN} - 10 \right]}$$

in which P = mean weighted storm rainfall (inches)
 Q = watershed storm runoff (inches)
 CN = a dimensionless coefficient representing combined effect
 of land use, soils and terrain roughness

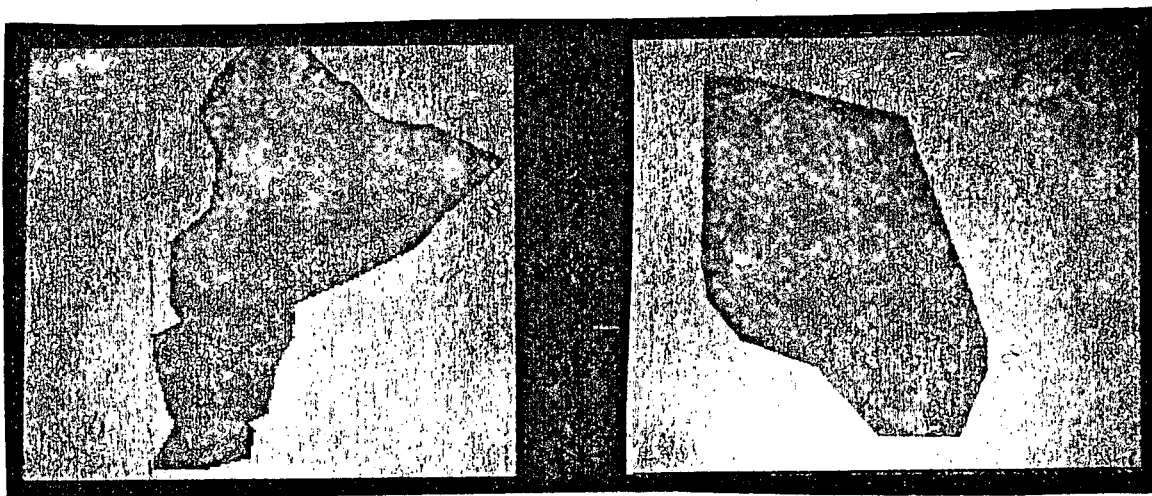
Equation 2

$$Q = C P^{2.15} API^{.278}$$

in which Q = watershed storm runoff (inches)
 C = a dimensionless coefficient representing differences in
 watershed conditions
 P = weighted mean storm rainfall (inches)
 API = 30-day decayed antecedent rainfall index derived using
 inverse temperature curves to adjust for seasonal
 variations

Table 1.--Watershed Coefficients for Chickasha ERTS Study

<u>Watershed No.</u>	<u>Drainage Area</u>	<u>CN (Eq. 1)</u>	<u>C (Eq. 2)</u>
111	26.0	60.9	.038
121	205.9	58.6	.023
141	73.5	58.0	.023
205	23.7 A	54.4	.039
206	27.2 A	53.6	.034
207	19.2 A	75.8	.122
208	18.5 A	77.4	.147
311	25.3	69.6	.078
511	59.4	69.4	.082
512	35.2	67.2	.050
513	19.24	65.7	.054
5141	6.35	61.5	.041
5142	.563	59.4	.027
5143	.759	56.3	.021
5144	2.276	62.8	.066
5146	1.190	63.8	.068
5220	207.8	57.1	.031
611	7.57	70.2	.065
612	.88	66.7	.057
621	33.3	67.4	.057



ERTS DATA

Irregular Shaped Watersheds Displayed on Video Screen